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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/650,193

08/28/2003

Koichi Ohto

Q77191

6245

23373

7590

11/03/2004

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EXAMINER

WILLIAMS, ALEXANDER O

ART UNIT

PAPER NUMBER

2826

DATE MAILED: 11/03/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

### Application No.

10/650,193

### Applicant(s)

OHTO ET AL.

### Examiner

Alexander O Williams

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 11 August 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-212 is/are pending in the application.
- 4a) Of the above claim(s) 18-50 and 52-212 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-17 and 51 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☒ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

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Serial Number: 10/650193 Attorney's Docket #: Q77191

Filing Date: 8/28/03; claimed foreign priority to 5/8/02; 10/17/03; 5/5/03

Applicant: Ohto et al.

Examiner: Alexander Williams

Applicant's election of Species I, figures 5A-8C (claims 1 to 17 and 51), filed 8/11/04, has been acknowledged.

This application contains claims 18-50, 52, 53 and 54-212 drawn to an invention non-elected with traverse.

Acknowledgment is made of applicant's claim for foreign priority based on an application filed in Japan on 10/17/03 and 5/5/03. It is noted, however, that applicant has not filed a certified copy of the foreign application as required by 35 U.S.C. 119(b).

The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

The disclosure is objected to because of the following informalities:  
Applicant's CIP related application information should be updated.

Appropriate correction is required.

Claims 3 to 7, 12 and 51 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 3, it is unclear and confusing to what is meant and what shows "said low-k material layer comprises one of a ladder-type hydrogen siloxane layer and a porous ladder-type hydrogen siloxane layer." For the elected species, where is this low-k material layers discussed in the specification? It appears for the elected species that silicon dioxide is discussed.

In claims 12 and 51, it is unclear and confusing to what is meant by "wherein said first silicon-diffused metal layer includes no metal silicide." How is there no metal silicide in a layer that comprises silicon and a metal? How does this relate to the elected species?

Any of claims 3 to 7, 12 and 51 not specifically addressed above are rejected as being dependent on one or more of the claims which have been specifically objected to above.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1 to 10 and 12 to 15, **insofar as some of them can be understood**, are rejected under 35 U.S.C. § 102(e) as being anticipated by Chambers et al. (U.S. Patent Application Publication # 2003/0137050 A1).  
1. Chambers (figures 1 to 8) specifically figure 1 show a semiconductor device comprising: an insulating underlayer **160**; a first insulating interlayer **100** formed on said insulating underlayer, said first insulating interlayer having a groove; a first silicon-diffused metal layer **120** buried in said groove; and a first metal diffusion barrier layer **110** formed on said first silicon-diffused metal layer and said first insulating interlayer.

DOCUMENT-IDENTIFIER: US 20030137050 A1

TITLE: Enhancement of an interconnect

Brief Description of Drawings Paragraph - DRTX (7):

[0011] FIG. 5 depicts an embodiment of a cross-sectional view of the substrate of FIG. 4 after application of a passivation layer and diffusion of silicon into the carbon-doped copper interconnect.

Detail Description Paragraph - DETX (22):

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[0035] Referring now to FIG. 5, there is shown an embodiment of a cross-sectional view of the substrate of FIG. 4 after application of a passivation layer and diffusion of silicon into the carbon-doped copper interconnect. After the metallization layer, a layer of interconnects and dielectric, may be planarized or polished, the surface may be cleaned with a plasma such as ammonia (NH.sub.3), hydrogen (H<sub>2</sub>), argon (Ar), or other reducing agent, and exposed to silane (SiH.sub.4) gas in a reaction chamber, before forming an etch stop layer such as silicon nitride (Si.sub.3N.sub.4) 510 or a silicon carbide (SiC) layer.

Detail Description Paragraph - DETX (34):

[0047] Doping the carbon-doped copper interconnect with silicon at a concentration that avoids formation of a copper silicide layer on the carbon-doped copper interconnect 630 may distribute silicon uniformly through the carbon-doped interconnect. In some embodiments, the diffusion of silicon uniformly through the carbon-doped interconnect may improve adhesion between the interconnect and an overlying layer. In alternative embodiments, doping the carbon-doped copper interconnect with silicon may comprise doping a layer near a surface of the carbon-doped interconnect with silicon to change the adhesion properties of the surface.

[0048] Doping the carbon-doped copper interconnect with silicon at a concentration that avoids formation of a copper silicide layer on the carbon-doped copper interconnect 630 may comprise cleaning the carbon-doped interconnect with a plasma; exposing the carbon-doped copper interconnect to silane after cleaning; and depositing an etch stop layer on the carbon-doped copper interconnect after exposing to diffuse silicon into the carbon-doped copper interconnect 635. Cleaning part of the carbon-doped layer with plasma may comprise cleaning the surface of the carbon-doped copper, and, in some embodiments, the surface of the metallization layer, with ammonia. In other embodiments, cleaning part of the carbon-doped layer with plasma may comprise cleaning the surface of the carbon-doped copper with H.sub.2.

Detail Description Paragraph - DETX (45):

[0058] Doping a remaining part of the carbon-doped copper layer with silicon at a concentration to avoid formation of a copper silicide layer on the carbon-doped copper layer 790 may comprise doping the carbon-doped

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copper interconnect as defined after polishing with silicon by ion implantation and/or diffusion. For example, silicon may be diffused into the copper by placing the remaining part of the carbon-doped copper layer into a reaction chamber; generating plasma in the reaction chamber; and releasing silane into the reaction chamber to diffuse silicon into the remaining part of the carbon-doped copper layer 795.

2. The device as set forth in claim 1, Chambers et al. show wherein said first insulating interlayer comprises at least one of **a SiO<sub>2</sub> layer**, a SiCN layer, **a SiC layer**, a SiOC layer and **a low-k material layer**.
8. The device as set forth in claim 1, Chambers et al. show wherein said first silicon-diffused metal layer has a larger silicon concentration near an upper side thereof than near a lower side thereof.
9. The device as set forth in claim 1, Chambers et al. show wherein said first silicon-diffused metal layer comprises a silicon-diffused copper layer.
10. The device as set forth in claim 9, wherein a silicon component of said silicon-diffused copper layer is less than 8 atoms %.
12. The device as set forth in claim 1, Chambers et al. show wherein said first silicon-diffused metal layer includes no metal silicide.
13. The device as set forth in claim 1, Chambers et al. show wherein said first silicon-diffused metal layer includes hydrogen.
14. The device as set forth in claim 1, Chambers et al. show wherein said first silicon-diffused metal layer includes **carbon**.
15. The device as set forth in claim 1, Chambers et al. show wherein said first metal diffusion barrier layer comprises at least one of a SiCN layer, a SiC layer, a SiOC layer and an organic material layer (**see paragraph [0021] to [0027]**).

Initially, it is noted that the 35 U.S.C. § 103 rejection based on a silicon diffused copper layer and a SiC etching stopper layer; and W diffusion layer and the silicon diffused copper layer deals with an issue (i.e., the integration of multiple pieces into one piece or conversely, using multiple pieces in replacing a single piece) that has been previously decided by the courts.

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In Howard v. Detroit Stove Works 150 U.S. 164 (1893), the Court held, "it involves no invention to cast in one piece an article which has formerly been cast in two pieces and put together...."

In In re Larson 144 USPQ 347 (CCPA 1965), the term "integral" did not define over a multi-piece structure secured as a single unit. More importantly, the court went further and stated, "we are inclined to agree with the solicitor that the use of a one-piece construction instead of the [multi-piece] structure disclosed in Tuttle et al. would be merely a matter of obvious engineering choice" (bracketed material added). The court cited In re Fridolph for support.

In re Fridolph 135 USPQ 319 (CCPA 1962) deals with submitted affidavits relating to this issue. The underlying issue in In re Fridolph was related to the end result of making a multi-piece structure into a one-piece structure. Generally, favorable patentable weight was accorded if the one-piece structure yielded results not expected from the modification of the two-piece structure into a single piece structure.

Claims 11, 16, 17 and 51, **insofar as some of them can be understood**, are rejected under 35 U.S.C. § 103(a) as being unpatentable over Chambers et al. (U.S. Patent Application Publication # 2003/0137050 A1).

11. The device as set, forth in claim 1, Chambers et al. show wherein said first silicon-diffused metal layer comprises a silicon-diffused copper alloy layer including at least one of Al, Ag, W, Mg, Fe, Ni, Zn, Pd, Cd, Au, Hg, Be, Pt, Zr, Ti and Sn (layer 110 contain tungsten which is directly connect to the silicon diffused copper).

16. The device as set forth in claim 1, Chambers et al. further comprising a first etching stopper between said insulating underlayer and said first insulating interlayer (**see paragraph [0021] to [0027]**).



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17. The device as set forth in claim 16, Chambers et al. show wherein said first etching stopper comprises at least one of a SiCN layer, a SiC layer, a SiOC layer and an organic material layer (**see paragraph [0021] to [0027]**).

51. Chambers (figures 1 to 8) specifically figure 1 show a semiconductor device comprising: an insulating underlayer **160**; an insulating inter layer **100** formed on said insulating underlayer, said insulating interlayer having a groove; a barrier metal layer (**see paragraph [0021] to [0027]**) made of at least one of Ta, TaN, Ti, TiN, TaSiN and TiSiN formed within said groove; a silicon-diffused copper layer **120** including no copper silicide and buried in said groove on said barrier metal layer, said silicon-diffused copper layer having a silicon component of less than 8 atoms X; and a copper diffusion barrier layer (**see paragraph [0021] to [0027]**) made of at least one of SiCN, SiC, SiOC and organic material and formed on said silicon-diffused copper layer and said insulating interlayer.

Therefore, it would have been obvious to one of ordinary skill in the art to use the SiC etching stopper and the silicon-diffused copper layer and the **w diffusion layer and the silicion diffused copper layer** as "merely a matter of obvious engineering choice" as set forth in the above case law.

The listed references are cited as of interest to this application, but not applied at this time.

Field of Search	Date
U.S. Class and subclass: 257/750,750,758,257,774,762	11/1/04
Other Documentation: foreign patents and literature in 257/750,750,758,257,774,762	11/1/04
Electronic data base(s): U.S. Patents EAST	11/1/04

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Any inquiry concerning this communication or earlier communications from the examiner should be directed to Alexander O Williams whose telephone number is (571) 272 1924. The examiner can normally be reached on M-F 6:30-7:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on (571) 272 1915. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Alexander O Williams  
Primary Examiner  
Art Unit 2826

AOW  
11/1/04